HF Antennas, the Seasons, Time of Day, Sunspot Cycles, Propagation, and the Ionosphere

HF propagation depends on what we call skywave or skip, albeit ground wave works OK line of sight especially on 160m and 80m. With skywave we bounce signals primarily off the F-layer of the ionosphere at 50-300 miles ASL, which acts a lot like a mirror/reflector. This bounce phenomena is, in general, what accounts for most HF contacts (QSOs). The F layer of the ionosphere is affected by the sun. Daytime changes, seasonal changes, and the 11-year sunspot cycle greatly influence the ionization of the F-layer. The general idea is that higher density ionization (more activated ions) the more reflective the F layer will be and the better the skip/propagation. We call that GOOD conditions.

There are many other intricate characteristics of the relationship between old Sol and our ionosphere (the ionosphere moves, wiggles, expands, contracts, and swirls); the D-layer absorbs radiation during daytimes on 160m, 80m, and 60m bands, but not after dusk. There is also E layer and tropospheric propagation phenomena when weather conditions are just right, as well as seasonal characteristics that affect propagation, solar storms, etc. Understanding the above basics helps understanding HF antenna characteristics. HF operators will experience that different frequencies will interact with the ionosphere in different ways as ionospheric refraction is wavelength specific. All this is in books and the internet, but it comes more directly with daily practice through many seasons and sunspot cycles.

The bottom part of the Sunspot Cycle

The 11-year sunspot cycle takes the shape of bell curve. When the 11-year solar cycle is **down** (4-5 years out of 11), HF skywave propagation above 20m (6, 10, 12, 15, 18 meters) is severely curtailed. Then reflection on all HF bands is diminished where most of the signal goes through the rarefied ionosphere to outer space and is thus not reflected back to earth stations. However, 160m, 80m, 60m, 40m, 30m, and 20m are often usable. Late at night 60m, 80m, and 160m are reliable. At night until dawn 40m is good for DX only.

Long skip (DX) can be had late at night because **lower angles** of incidence through the ionosphere hit more ions (the ionosphere is thicker), but near vertical incidence skywave (NVIS, or short skip will hit less ions and pass through the F layer more easily. That translates as unreliable short hops. For example, near vertical incidence skywave on 80m and 60m is good for 200 miles during the day on 80m despite D layer absorption. It's reliable, but less so during the troughs of the sunspot cycle. For the 6 or 7 years of high sunspot activity NVIS is reliable on 40m during the day and for 60m, 80m, and 160m both night and day. Therefore, disaster service organizations target 40m, 60m, and 80m for close in disaster communications. The idea is to shoot the signal up 200 miles or so to be reflected and let it bounce straight back down maximizing the coverage of the whole county and state. **Lower** incidence angles of radiation would maximize contacts with distant stations but sacrificing sending signals straight up that would maximize short skip.

Choosing an Antenna

Therefore, vertical antennas are known for low angle take offs, hence, they are not good for NVIS. They may be good for ground wave and for DX, as well as omni-directional needs, however, they are a compromise antenna for NVIS. Often it is described that verticals propagate equally bad in all directions.

Shortened antennas with traps or coils introduce coil loss depending on the Q of the antenna. One can easily lose 9/10 of the signal. If it is vertical or end fed it requires radials or an excellent ground or counter poise system. If radials are not used, then only an excellent ground system might suffice as long as the conductivity of the soil or sea water is exceptional.

End fed and verticals are considered unbalanced antennas and are subject to pick up more RF noise than balanced antennas like a dipole fed by window line or balanced open wire line. Coax itself offers advantages only in so far that you can run it anywhere, but it can also be noisy and lossy, in general (transmission line characteristics is another large subject). Loop antennas are best for low noise reception. That is also another separate subject. Antenna considerations will need to be customized according to physical characteristics of the lot, house, geography, band, and individual priorities.

Conclusion

For EmComm communications for 100-300 miles and less), using a horizontal radiator approximately 1/4 wavelength above the ground will have a significant vertical radiating component. Therefore a 80m dipole less than 65' above the ground will maximize NVIS propagation. Anything taller or lower will depreciate it.

Similarly, calculations for 60m and 40m will reveal approximately 50' and 33' above ground respectively will provide significant NVIS. Those are antenna height calculations for NVIS above a perfect ground in free space (no objects in the field)). Of course, perfect ground and free space are impossible, but in general this is a good approximation.

Although there are a lot of good articles on the internet regarding NVIS, there is also a lot of junk about NVIS that doesn't calculate ground loss. One needs to know propagation, antennas, and have some actual experience. For example, as a weekly NCS on a County Wide EmComm Net on 80m I can hear everyone, while no one else can do so. Everyone can hear my signal, albeit I cheat with an amp. But the bottom line is receiving. Many people have very high noise levels on 80m because of ambient manmade (vertically polarized) noise. Noise can be ameliorated greatly by avoiding coax as a feedline. But I can now hear everyone, which I could not when I had an OCFD fed with coax.

Checking-in regularly to a Net (such as the NCN) which meets twice nightly, one can experience directly the effects of propagation shifts between the two nets at 7pm and 9pm.

The latter net always has longer propagation characteristics. The NTS regional net (RN6) meets between the two NCN nets also on 80m. It includes Southern California. There longer distance propagation is needed. Then the AREA Wide Net meets after RN6 which covers all of the West Coast, Rocky Mountain states, and parts of the Southwest. There low angle radiation is preferred. With practice one gets to know more about HF antennas and propagation. It's a fascinating and intricate subject.

Lots of trial and errors, study, asking questions, and daily operation through a few sunspot cycles all have moved me to novice 2 class. I'm still learning. Space weather is always changing.

Good luck

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